



# **Armed Forces College of Medicine AFCM**



# **Juxtaglomerular apparatus, Ureter & Urinary bladder**

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**Histology Department**

# INTENDED LEARNING OBJECTIVES (ILO)



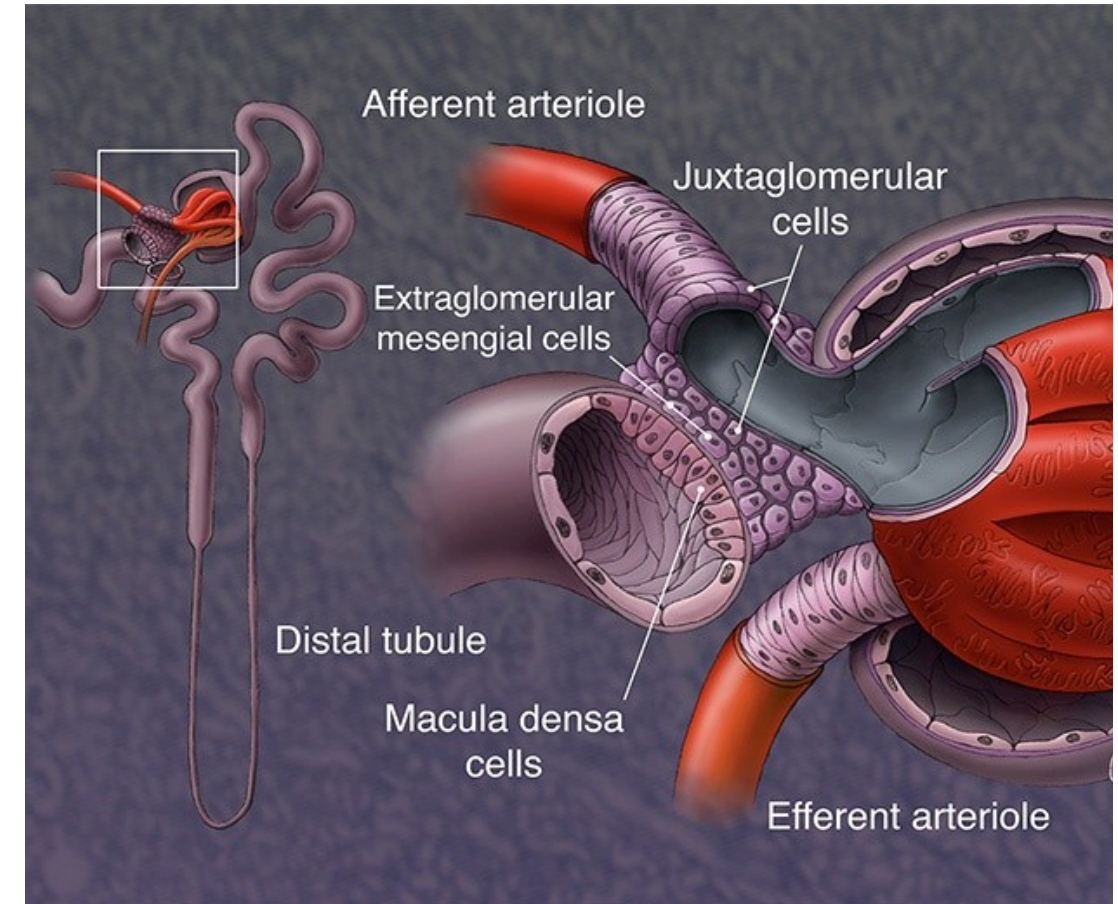
By the end of this lecture the student will be able to:

- 1. Correlate** the microscopic structure of the JG complex components (macula densa and JG cells) to their function.
- 2. Describe** the microscopic structure of the ureter and urinary bladder.
- 3. Correlate** the microscopic structure of the urinary bladder epithelium to its function.
- 4. Interpret** the histological changes in urinary bladder in various diseases.

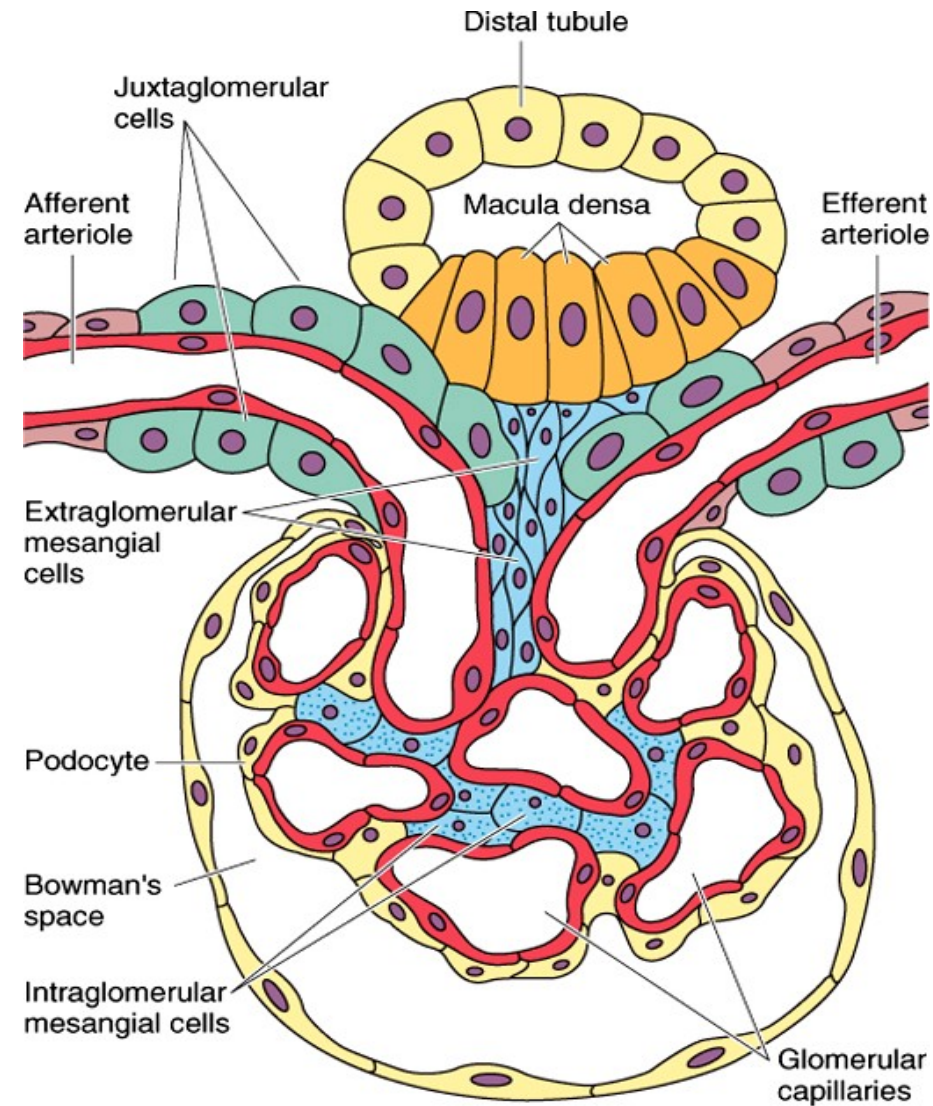
# Juxtaglomerular apparatus “JGA”



- Present at the **vascular pole** of the glomerulus.
- Present at sites where **DCT** fits between **afferent & efferent arterioles**.
- Structure:
  - **Macula densa cells.**
  - Juxtaglomerular cells.
  - Lacis cells "Extraglomerular Mesangium".



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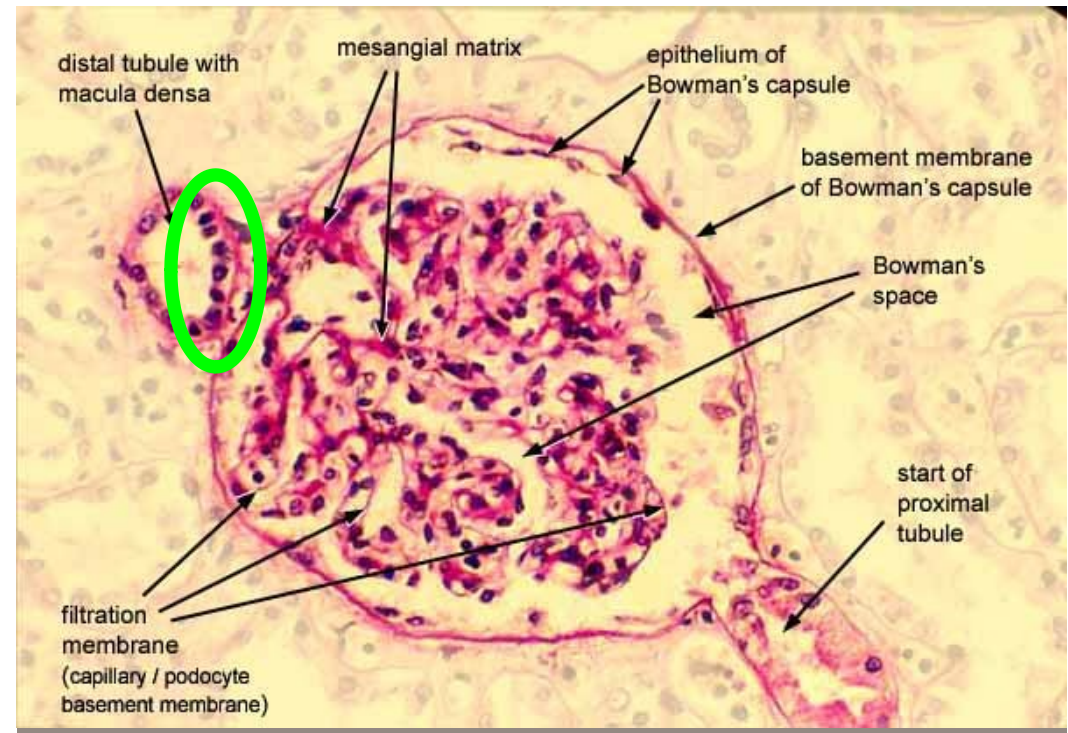
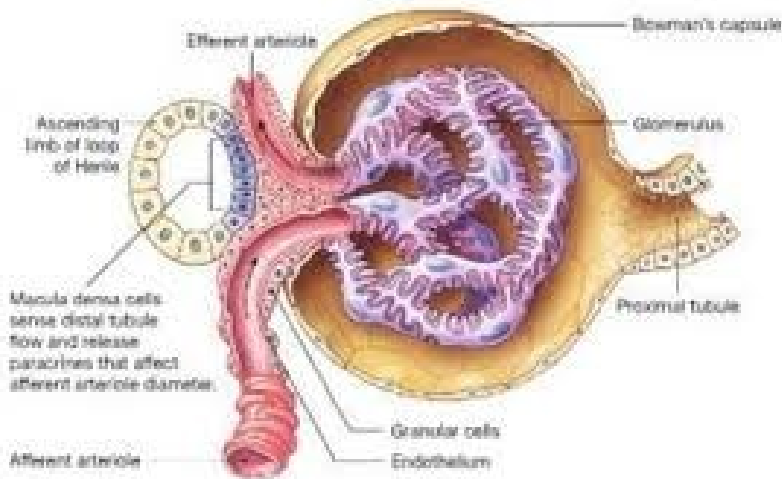


## A ) Macula Densa



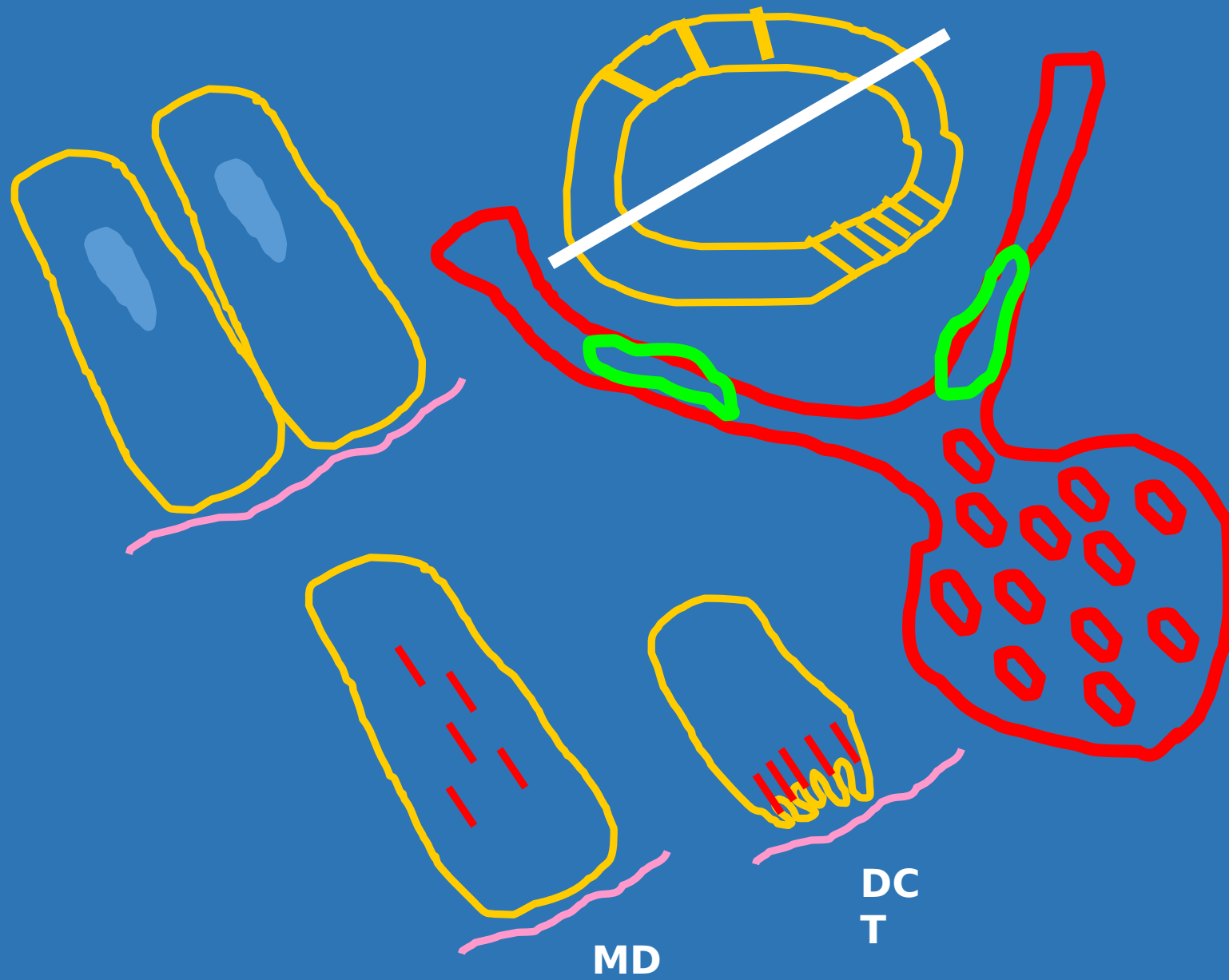
- Part of **Distal convoluted tubule** where it faces the glomerulus.

- Lining is **modified** from **simple cuboidal** to **columnar**



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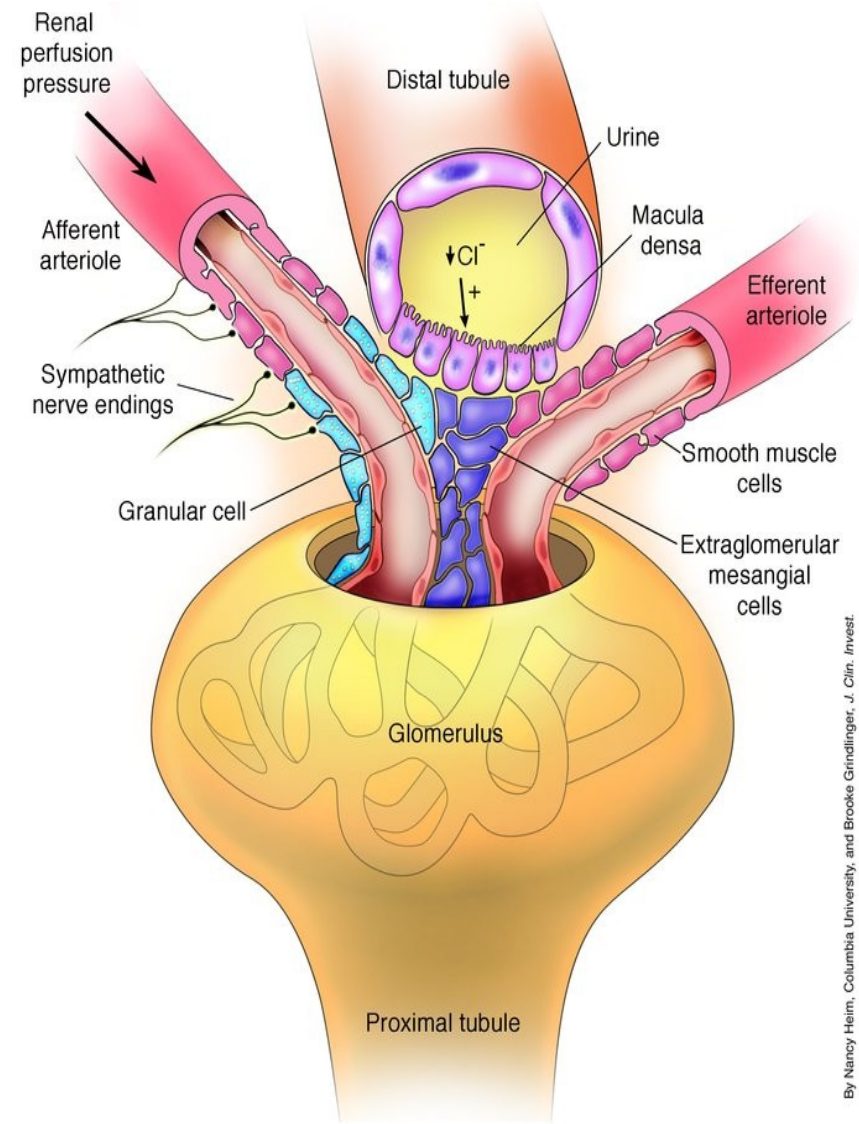
No  
microvilli







- Tall narrow closely packed cells.
- Deeply stained nuclei closer to the **apex**.
- No basal infoldings.
- Widely distributed small **mitochondria**.
- Numerous apical **microvilli**.
- Golgi apparatus is **basal** "infra-nuclear"
- Cell processes extend through the lacking basement membrane.



By Nancy Heim, Columbia University, and Brooke Grindlinger, J. Clin. Invest.

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## Function of macula densa:

### "SENSORY"

- Detect the **sodium levels** and **flow rate** of tubular fluid.



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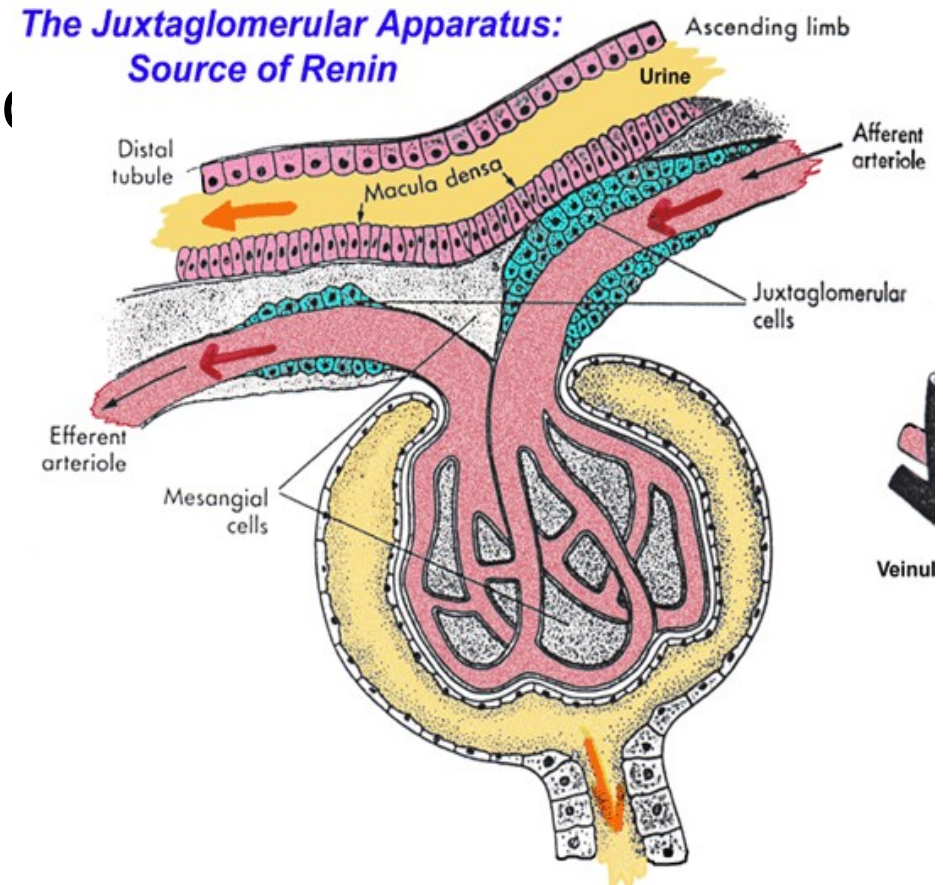


	<b>DCT</b>	<b>Macula densa</b>
<b>Function</b>	Ion transporting	Sensory
<b>Lining epithelium</b>	Low cubical cells	Tall cuboidal/ columnar
<b>Nucleus</b>	Rounded and central	Closely packed apical nuclei
<b>Basal membrane infoldings</b>	Highly developed	Not present
<b>Mitochondria</b>	Basal and longitudinally placed	Scattered
<b>Microvilli</b>	No microvilli	Numerous microvilli
<b>Golgi apparatus</b>	Small	Large and basally located
<b>Basal processes</b>	Absent	Present
<b>Basement membrane</b>	Continuous	Discontinuous

## B) Juxtaglomerular Cells



- **Modified smooth muscle cells** (the **afferent arteriole** "mainly" where it approaches the glomerulus.
- They are modified to be **protein synthesizing cells**, so:



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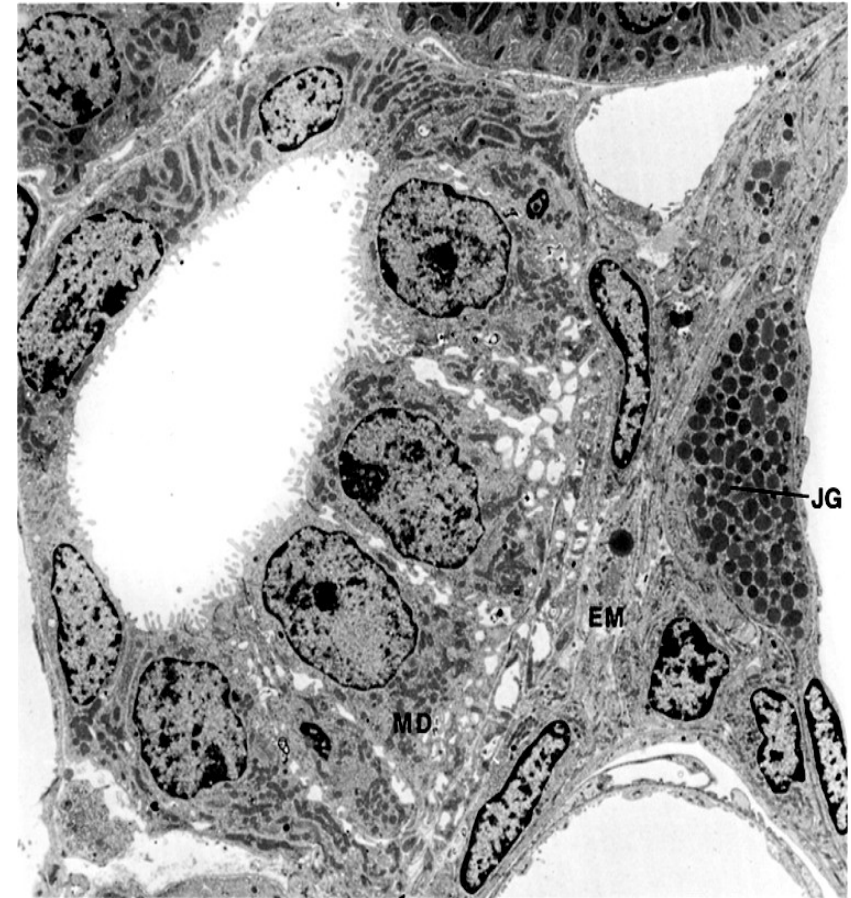
## LM:

- Cells are rounded.
- Cytoplasm **basophilic**.
- Cytoplasm has **PAS +ve** secretory granules.

## EM:

- Prominent rER, Golgi apparatus, mitochondria
- Secretory granules.

- **Function:** Renin secretion



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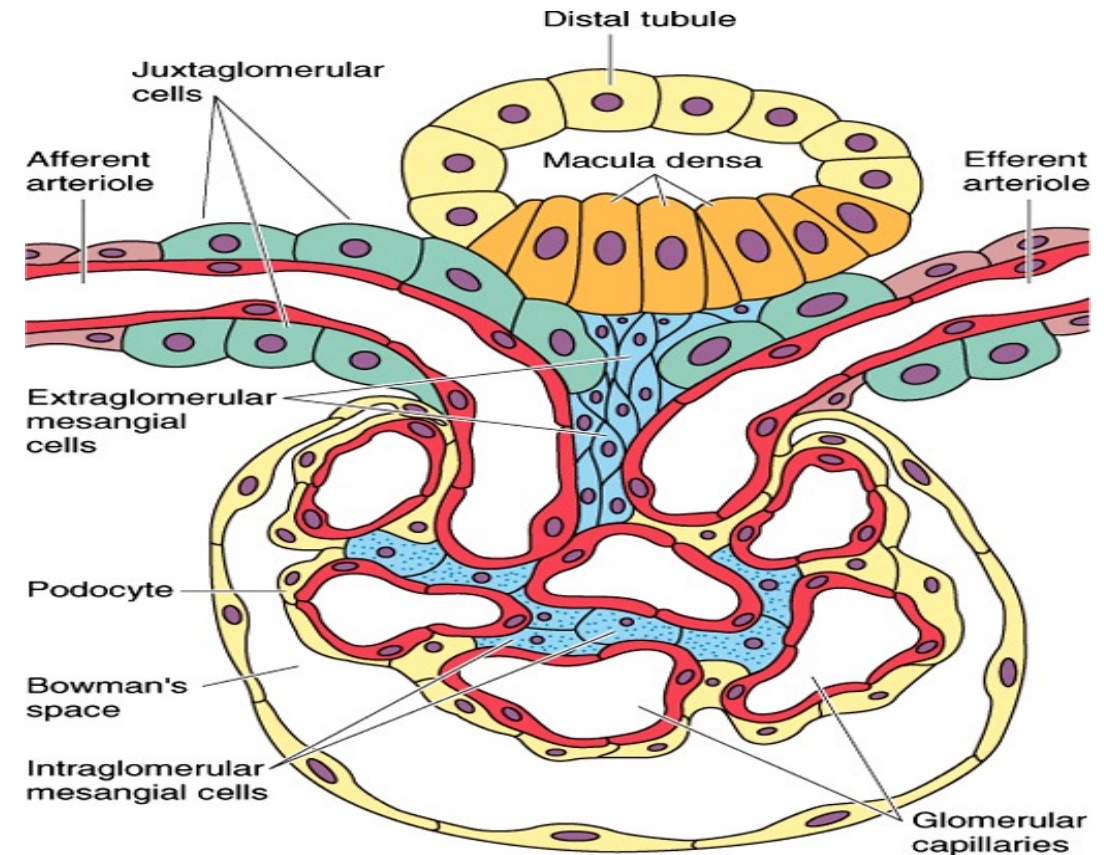
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# Structure function adaptation of juxtaglomerular cells



- Absence of internal elastic lamina: to be in close contact with the endothelium of the arteriole.
- Close to the cells of macula densa.
- Innervated by sympathetic nerve fibers.



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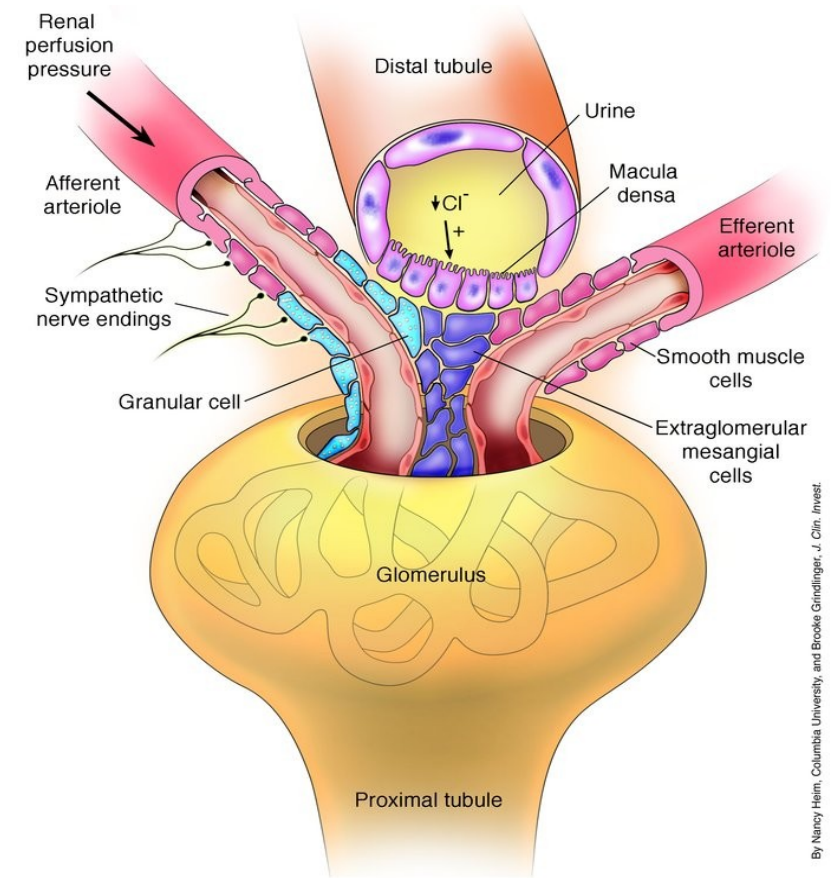
# Function of the JGA



- Juxtaglomerular cells secrete **renin** in response to **fall in blood pressure** in different ways:

- Degree of stretch in wall of afferent arteriole.

- Sympathetic stimulation.



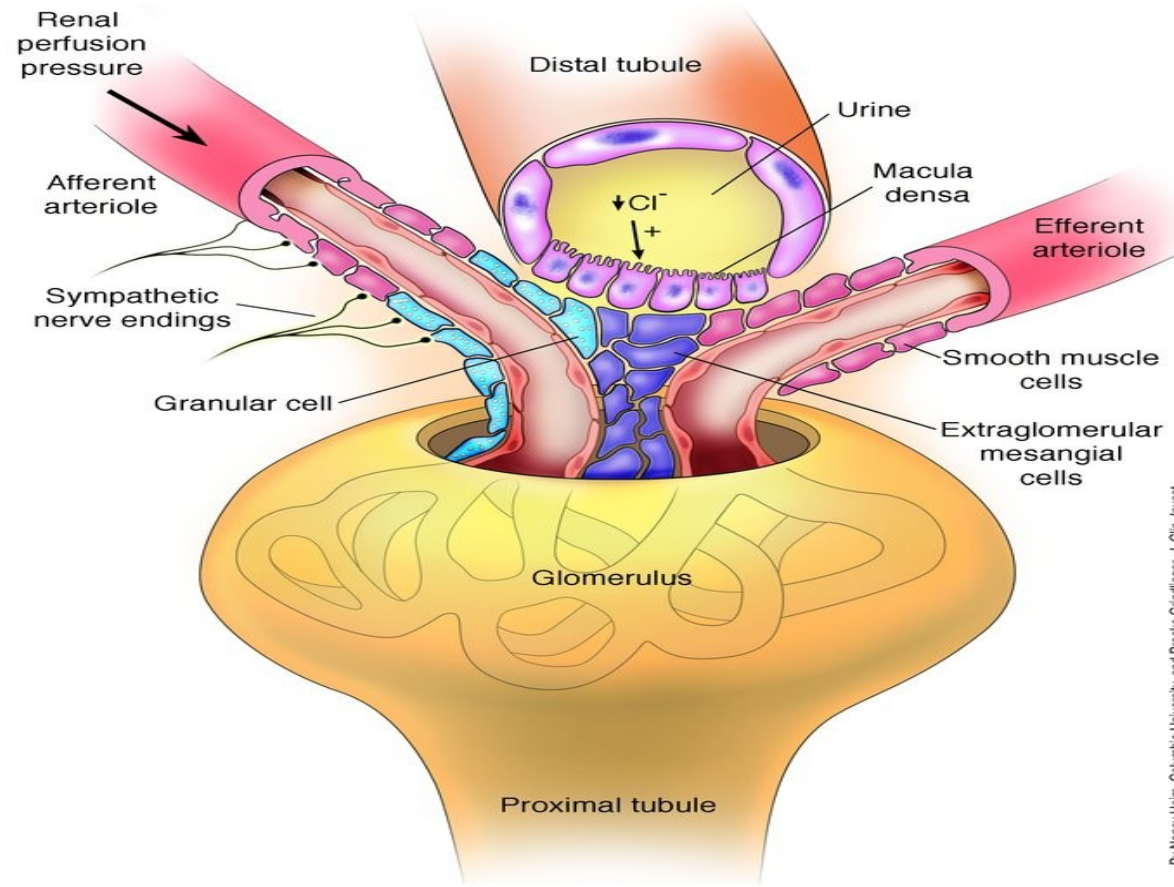
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## C) Lacis cells (Polkissen)



- They are **extraglomerular mesangial** cells.
- Group of small cells with pale nuclei.
- Lying between afferent & efferent arterioles.
- Cells connected by **gap junctions**.
- They are supporting cells



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# Renal Interstitium



- It is the connective tissue of the kidney.
- **In cortex:** it is **fine and minimal** and has **two types of interstitial cells:**
- **Fibroblast-like cells:** secrete **erythropoietin**
- **Mononuclear phagocytic cells**
  
- **In Medulla: extensive C.T.** and has ***Medullary Interstitial cell*** that secrete **medullipin I** → liver → medullipin II → V. D. → ↓ blood pressure.
  - *So, the kidney has **dual** effect on the blood pressure...how?*

*1- Medullipin I*

*2- Renin*

# Kidney Functions



- Water and electrolyte balance
- Acid base balance
- Excretion of waste products
- Excretion of drugs

Urine  
production  
**EXOCRI  
NE**

- Regulation of blood pressure
- Secretion of erythropoietin
- Conversion of prohormone vitamin D3 into the active form

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**MIXED GLAND**



## Medical applications



- **Acute tubular necrosis:**
- It is kidney injury caused by **damage to the cells lining the kidney tubules** that may progress to renal failure.
- Common causes are **low blood flow** to the kidneys (eg. low blood pressure), **drugs** that are toxic to the kidneys (eg. Excess usage of antibiotics and analgesics)

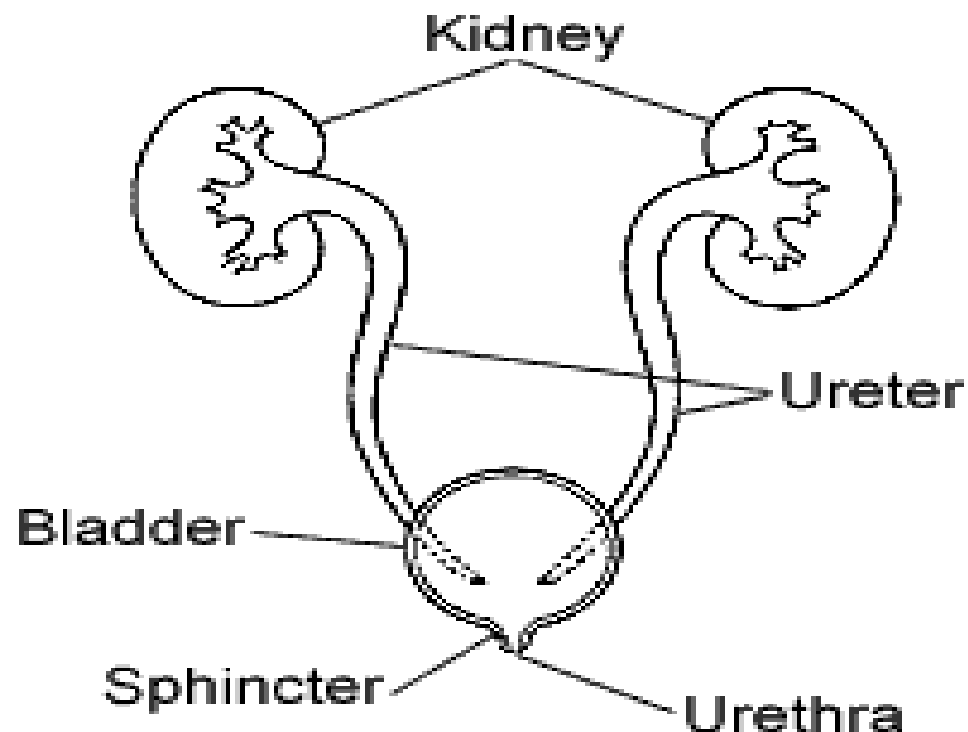
# Urinary Passages



- Calyces and pelvis
- Ureters
- Urinary bladder
- Urethra



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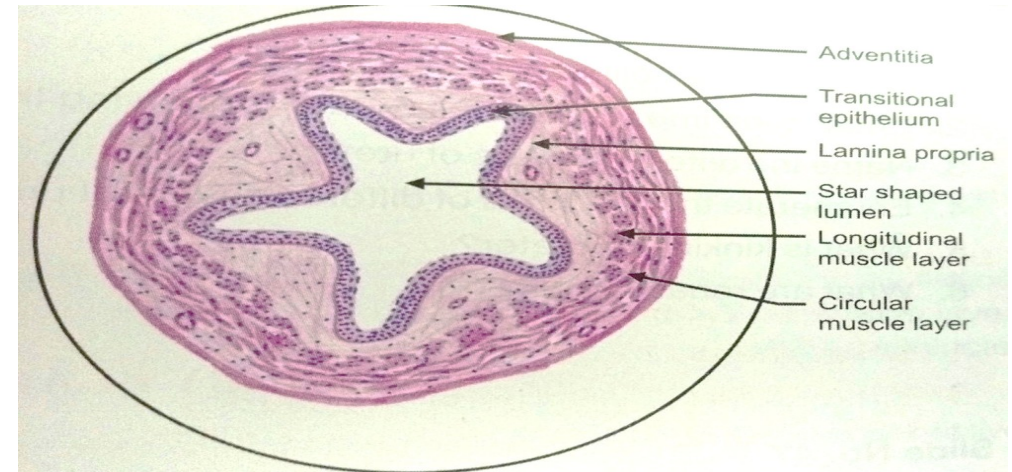
# Ureter



- The **lumen** of the ureter is narrow and stellate
- Its wall is formed of:
- **Mucosa:** consists of:
  - **Epithelium:** transitional epithelium
  - **Lamina propria:** loose C.T.
- **Musculosa:** formed of **smooth muscle** fibers arranged as:
  - Inner longitudinal
  - Outer circular
  - Additional outer longitudinal "in the lower 1/3"
- **Adventitia:** fibroelastic C.T.



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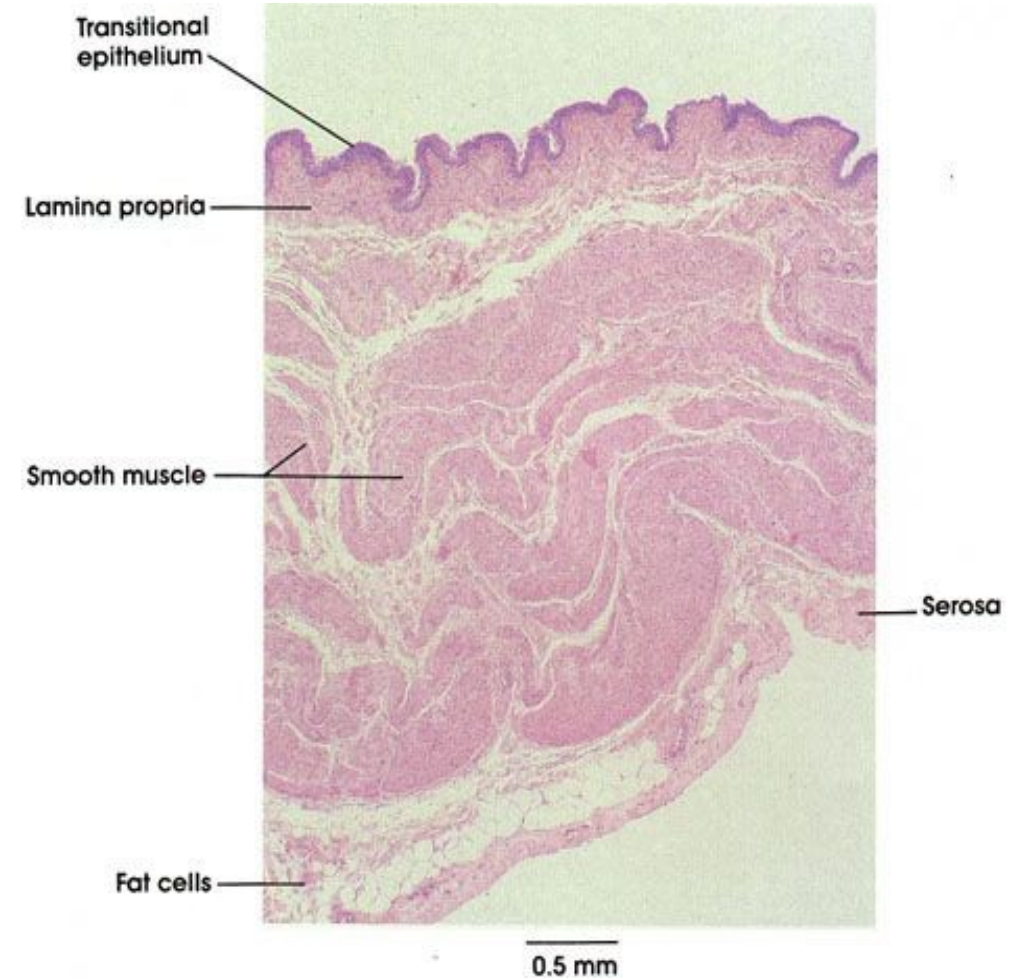


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# Urinary Bladder



- The lumen of the bladder is wider and folded
- Its wall is formed of:
- **Mucosa:** consists of:
  - **Epithelium:** transitional epithelium
  - **Lamina propria:** loose C.T.
- **Musculosa:** formed of **smooth muscle** fibers arranged in every direction, at the neck they are:
  - Inner longitudinal
  - Middle circular
  - Outer longitudinal
- **Adventitia:** fibroelastic C.T.



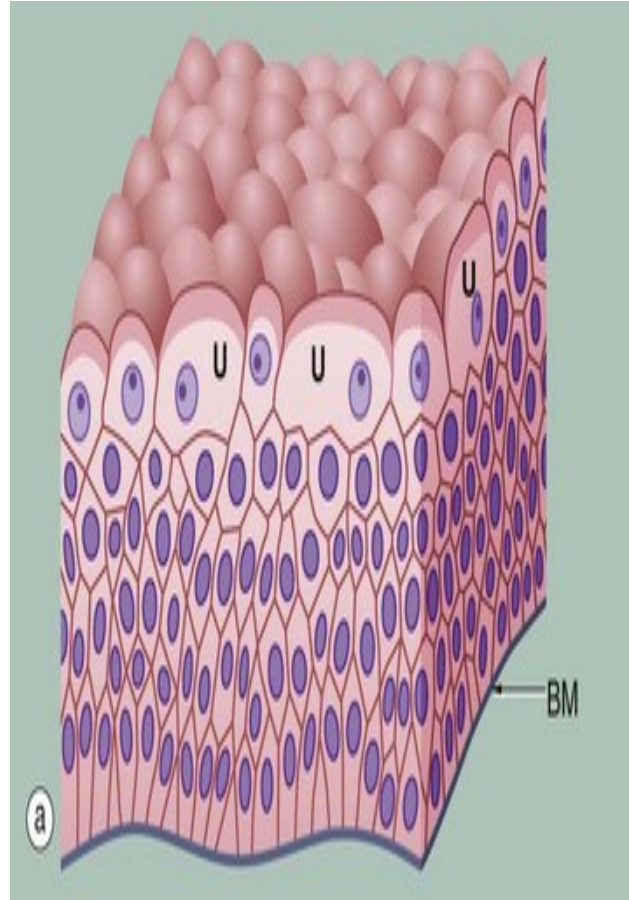
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# Transitional epithelium



- It is formed of 4-5 rows of cells
- The top layer is called **facet cells:**
  - Cubical or it may be squamous in distended bladder.
  - May be binucleated.



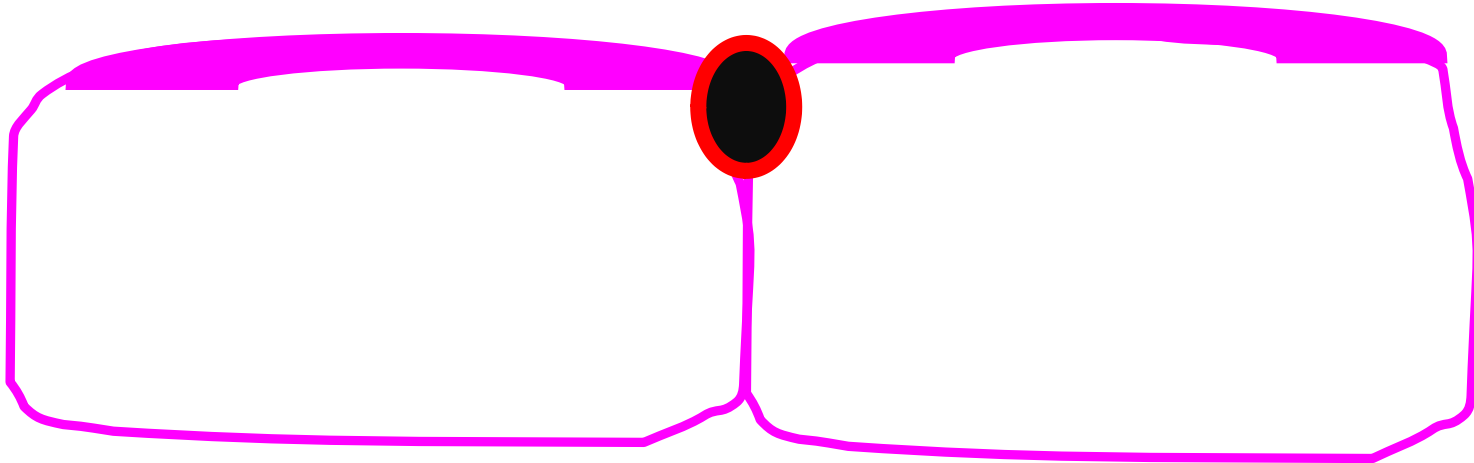
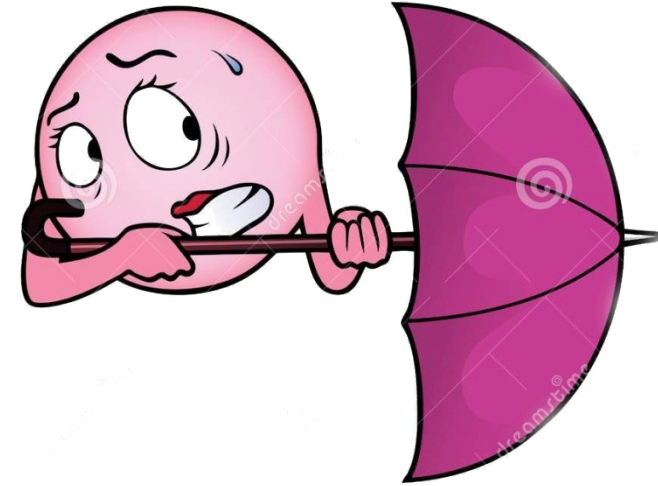
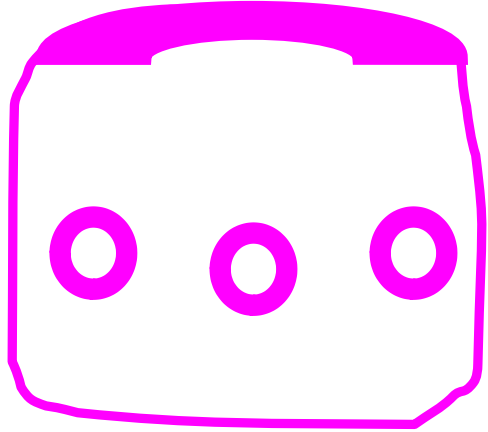
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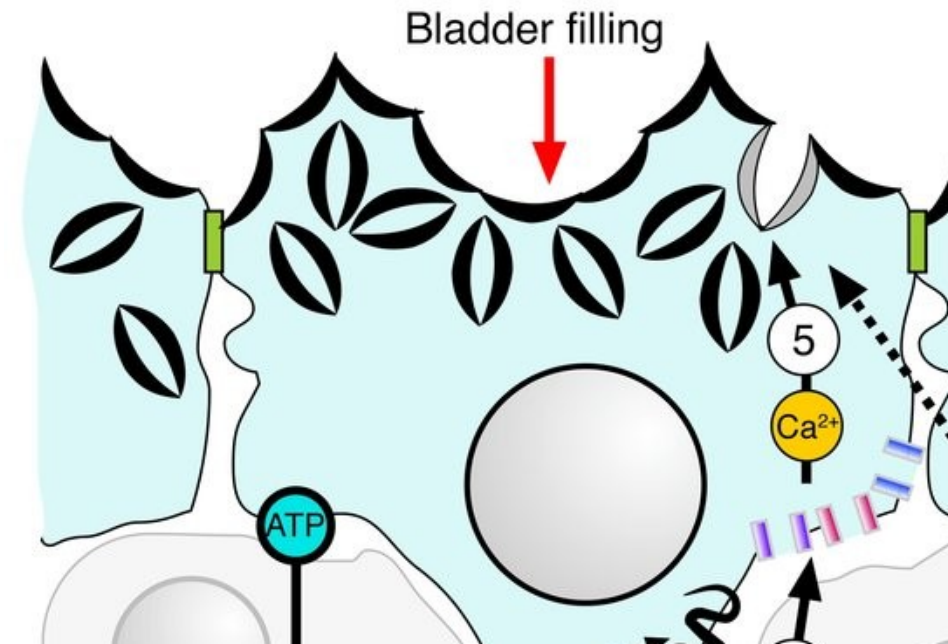
# Umbrella cells



# Facet cell “umbrella cell”



- Luminal cell membrane is **thick**.
- **Occluding junction** between the cells → barrier to the movement of **H<sub>2</sub>O** from blood as the urine is **hypertonic** “osmotic barrier”.

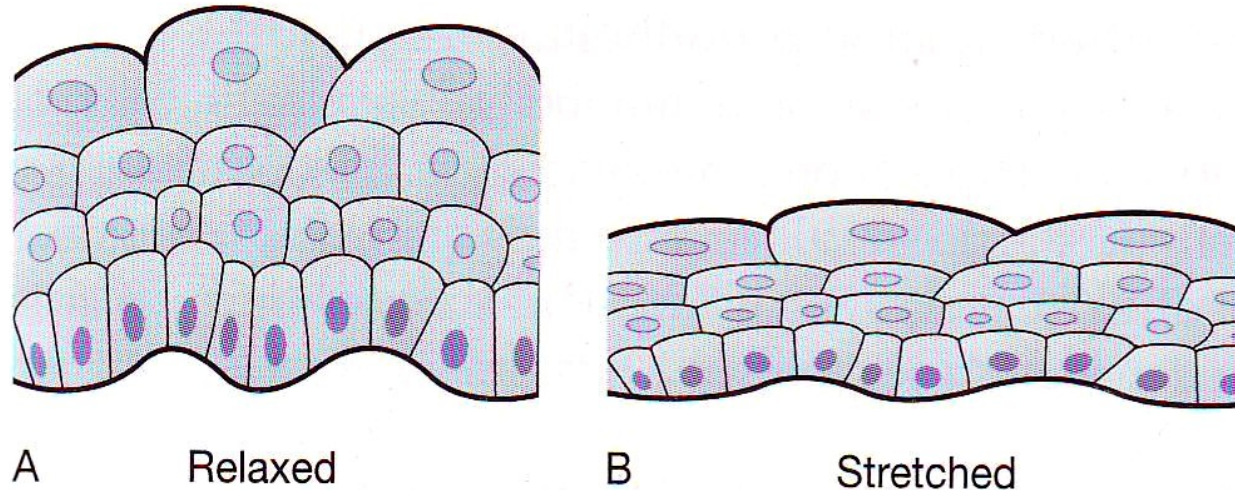


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# Facet cell “umbrella cell”



- **In empty bladder**, the apical membrane decreases its surface area and folds into **fusiform apical vesicles** → **reservoir for cell membrane**
- As the **bladder fills**, these apical vesicles fuse with the apical membrane increasing the surface area as the cell flattens.



<https://slideplayer.com/slide/6330822/21/images/27/Transitional+epithelium.jpg>



### • Cystitis:

- It is **inflammation** of the urinary bladder mucosa and it is the most frequent problem involving it.
- This inflammation is common during urinary tract infection, but it can also be caused by immunodeficiency, urinary catheterization, radiation or chemotherapy.
- Chronic cystitis can also affect the transitional epithelium lining the urinary bladder leading to transitional cell carcinoma.

# Summary



- ❑ Structure and correlated functions of components of the juxtaglomerular apparatus.
- ❑ Macula densa, site, structure and its role in juxtaglomerular apparatus.
- ❑ Juxtaglomerular cells, site, characters and their function in juxtaglomerular apparatus.
- ❑ Lacis cells, their site, and function as a part of the juxtaglomerular apparatus.
- ❑ The renal interstitium, the cortical and the medullary interstitial cells.
- ❑ The ureter is formed of three layers, mucosa, muscle layer and adventitia.
- ❑ The wall of the urinary bladder, is formed of three layers, mucosa, muscle layer and adventitia.
- ❑ Structure of the transitional epithelium.



# Lecture Quiz



## 1) The juxtaglomerular cells are formed of:

a. Podocytes.

☒ b. Modified smooth muscles mainly in afferent arteriole.

c. Intraglomerular mesangial cells.

d. Principal cells.

e. Lacis cells

## 2) Lacis cells are characterized by:

☒ f. Are present between afferent and efferent arterioles.

g. Show basal infoldings

h. Contain renin granules

i. Are connected by tight junctions

j. Show apical microvilli.



## 3-Facet cell of the urinary bladder is characterized by:

- ☒ a. May be binucleated.
- b. Luminal cell membrane is thin.
- c. Are attached together by adhering junction
- d. Having apical vesicles in full bladder.

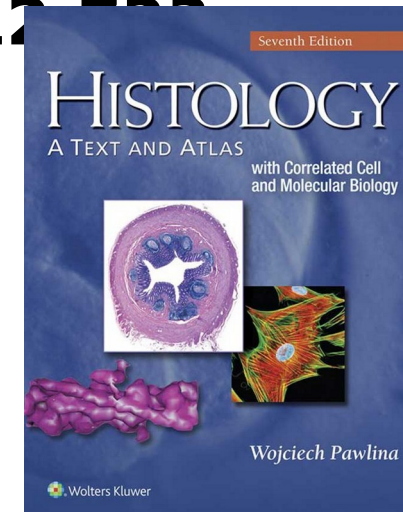
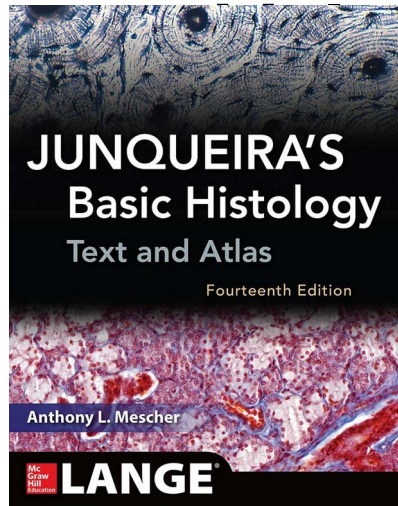
# SUGGESTED TEXTBOOKS



**1. Junqueira's Basic Histology: Text and Atlas, Fourteenth Edition  
by Anthony Mescher (2016) p. 404-406**

**2. Histology a text and atlas with correlated cell and molecular**

**gy by W. Pawlina (2016) p. 712-722**



**THANK  
YOU**

